# BOOK REVIEW

NACHTIGALL, W. 1974. Biological Mechanisms of Attachment. The Comparative Morphology and Bioengineering of Organs for Linkage, Suction and Adhesion. Springer-Verlag. New York, Heidelberg, Berlin. vii + 194 pages, 721 figures in 63 plates. Subject index. Cloth. No price given.

This is the age of the Reductionist in biology; of he who searches for fundamental laws which, he hopes, will apply to all organisms through all time. The reductionist is usually sure that, eventually, all biological processes will be explainable in the rigorous language of physics and mathematics.

One area in which this approach has been most productive is that of bioengineering: that "branch of biology which applies the methods of engineering and physics to the study of biological phenomena". Professor Nachtigall is an enthusiastic and ingenious contributor to this field, particularly with regard to locomotion in aquatic and flying insects. That he is also a talented populariser of science is obvious in this book and in his recent treatise on insect flight (reviewed by Craig (1975) in this journal (Quaest. Ent. 11(1): 111-112)). In addition, he is unusual among reductionists in that he has an appreciation for diversity. As he says in his preface: "At a time when research and teaching concentrate more and more on particular topics and examples. . . . it appears to me necessary that the biologist recall from time to time how extraordinarily varied are the possibilities which nature offers for solving any set of problems. This compendium of facts is intended to contribute to that end".

In this book Nachtigall describes about 500 structural types of biological attachment mechanism found in various plants and in animals from Protozoa to mammals. Arthropods and especially insects figure prominently in his discussions because of the endless adaptive flexibility exhibited by the arthropod exoskeleton. He treats the four principal types of attachments occurring in organisms (1) rigid and 2) flexible *permanent* attachments and 3) rigid and 4) flexible *releasable* ones) but does not include animal joints because ". . . one who undertakes this task can be expected to be inundated with a superabundance of structural designs. Even a moderately comprehensive summary would, by itself, fill another book".

Almost every mechanical gadget devised by man to aid him in his day-to-day activities can be found, often in identical form, in one or another organism. Carpenter's joints, plugs and sockets, hooks and eyes, snap fasteners, zippers, clamps, grippers, anchors, probabalistic fasteners, expansion fasteners, suction cups and glue and many others have their biological equivalents. These are discussed in order of their mode of action not according to the phylogeny of the organisms that bear them. Most devices he describes are illustrated with original figures extracted from the literature and organized into plates. These are liberally salted with clear diagrams of man-made gadgets having analogous functions.

When explaining how each works, Nachtigall uses the simple and precise terminology of the engineer. This practice sometimes does violence to the biologist's use of similar terms for homologous structures, but makes for easier understanding. Active students of biological structure and function will find in Nachtigall's book a ready source of precise terms to describe their findings.

Again and again Nachtigall shows that completely unrelated lines of organisms, when faced with similar problems, have solved them in similar ways through convergent evolution. His treatment of each organism and its device reveals a broad knowledge of plants and animals.

One of the most detailed and satisfying descriptions in the book is that concerning the six ventral suckers of larval Blephariceridae (pp. 100-106). The larvae of these nematocerous flies live in torrential streams on rocks where they "wander slowly over the diatomaceous meadows on which they feed". When a larva is moving, a maximum of three suckers may be released from the substrate at any one time. The other three must hold firm or the larva will be washed away be the current. The larva moults three times before pupating and each time is confronted with the problem of shedding its old cuticular suckers without losing its grip. It accomplishes this task by shedding each sucker in sequence so that the new suckers are already attached before the old ones are released. Also, each new sucker is formed by the epidermis in a functional condition above the old – ready to attach to the rock at the moment of ecdysis.

This description is one of very few in which the development of a structure is followed in detail. It serves to focus attention on a prominent void in our knowledge of animals – particularly of arthropods. The problems the epidermis faces in shedding and replacing complex, 3-dimensional articulations in immature arthropod bodies is one in great need of additional study even, it is hoped, by the mathematical topologist. There are too many generalizations in text books based on too few observations of too few animals.

Although this book is an "easy read" it should be consumed slowly and in small bites because of the overwhelming amount of detail it contains. When one does this one notices subtle dashes of humour that one would probably miss with a superficial reading. An example of this is his inclusion of Stümpke's imaginary Rhinograde "honey tail" in a paragraph on polyplacophoran Mollusca. "These animals attach themselves by means of the broadened nose to a pillar-like pedestal called the sella, which is secreted by special skin glands within the suction surface. They lead a sedentary life and break the attachment only during the mating season. Unfortunately, souvenir-hunting humans have decimated these singular inhabitants of tropical islands, so that closer investigation of their attachment mechanisms appears unlikely" (p. 88). Or, on page 162: "One fitting final example (of coiled connections) is the little known mode of copulation of the bug *Lygaeus equestris.* The remarkable, helical genitals of these animals and the "twisting" motions involved in their mating may even offer an entomological etymology of the curious American slang for this procedure!".

The success of the English addition of this book will be largely due to Dr. Marguerite Biederman-Thorson's sympathetic translation (she contributed equally successfully to the translation of Nachtigall's flight book).

My two criticisms concern the unfortunate printing of scientific names in Roman rather than in italics and the muddy reproduction evident in some plates (eg. Plate 19). Several others suffer from too much reduction such that details described in the text are difficult to follow in the drawings.

In an epilogue, Nachtigall states: "One can argue conservatively that the half-thousand structural types (of attachment mechanism) discussed here represent perhaps one percent of all the functional morphological devices which have been realized. A very wide field is open, not only to the biologist interested in mechanical design, but to the engineer as well, for the study of nature may lead him to new designs of his own". In conclusion I suggest that if Nachtigall succeeds in getting engineers to look more to nature when designing their devices and making their recommendations he will merit the gratitude of us all.

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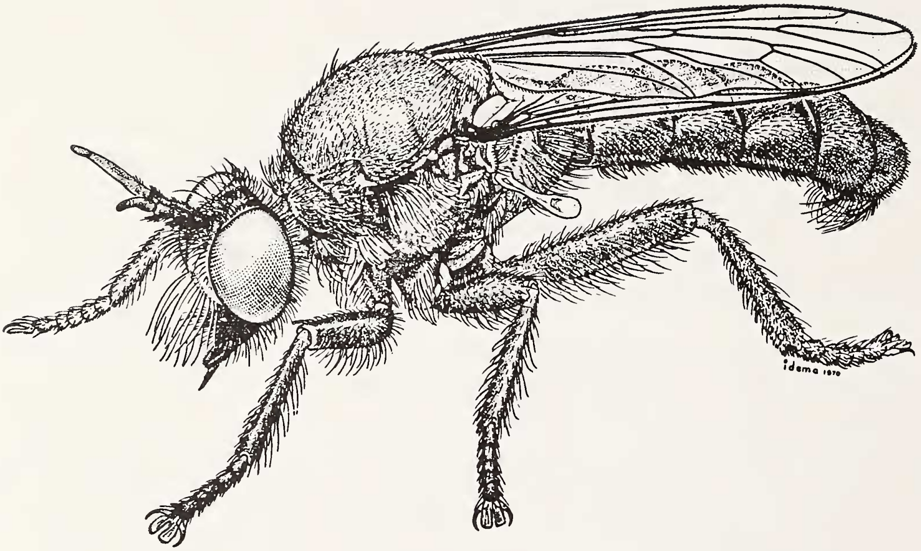

Frontispiece *Dicolonus sparsipilosum* Back, male.